REMARKS

The Office Action mailed March 22, 2004 is based upon pending Claims 1-59, 99 and 109-111. This Amendment, mailed in response to the March 22, 2004 Office Action, amends Claims 7, 24, 41, and 47. After entry of this Amendment, Claims 1-59, 99 and 109-111 are pending and presented for further consideration.

Rejection under 35 U.S.C. 101 and 35 U.S.C., first paragraph

As set forth in the March 22, 2004 Office Action, Claims 1-40, 99, and 109-111 are rejected under 35 U.S.C. §101 because the disclosed invention is inoperative and therefore lacks utility. Further, Claims 1-40, 99, and 109-111 are rejected under 35 U.S.C. §112, first paragraph, as failing to comply with the enablement requirement.

Independent Claims 1, 33, and 99 recite producing diffractive features through non-interference effects. Claim 34 recites non-holographically forming diffractive features.

The Office Action states that forming refractive index variations in the layer of curable material requires an interferometric/holographic exposure. The Office Action concludes therefore that producing diffractive features through non-intereference effects and non-holographically is not possible.

To address the rejection of Claims 1-40, 99, and 109-111, Applicants have contacted Prof. John Caulfield, a renown scientist in the field of holography. A copy of a Declaration executed by Prof. John Caulfield is attached. As set forth in Prof. Caulfield's declaration, diffractive features in the layer of curable material can be produced non-holographically or using non-interferometric effects by physically contacting a layer of curable material with a surface relief pattern and curing the curable material by propagating energy through the surface relief layer as recited in Claims 1-40, 99, and 109-111.

Prof. Caulfield specifically points out that interference is not necessary to form such diffractive optical elements. In general, the concept of interference does not enter into the definition of a hologram. A hologram is defined in the declaration as a transducer that operates on wavefronts, e.g., A and B, to provide a particular input/output mapping. Prof Caulfield points out that many holograms, such as for example, computer generated holograms and kinoforms, are made without interfering beams. Interference, thus, is not necessary.

Prof. Caulfiled cites additional evidence to support the conclusion that the diffractive

optical elements are formed through non-interferometric effects. In particular, Prof. Caulfield notes that the layer of curable material can be index matched with the medium having the surface relief pattern physically contacted thereto. Such a configuration is specifically recited in Claim 6. Even in the case where the medium having the surface relief pattern is index matched with the layer of curable material such that no diffraction and consequently no diffracted beam is available to produce interference, the process yields an efficient volume diffractive optical element. Prof. Caulfield concludes that such a configuration demonstrates that non-interferometric effects are responsible for producing the diffractive features.

Prof. Caulfield also refers to additional evidence to support the conclusion that the diffractive optical elements are formed through non-interferometric effects. Prof. Caulfield notes that UV lamps that are not temporally coherent and that are broadband may be employed to cure the layer of curable material. Sunlight may also be used. Prof. Caulfield explains that in general, attempts to produce interference with broadband temporally incoherent energy suffer low contrast. The product yielded by the process recited in Claims 1-40, 99, and 109-111, however, demonstrates high optical efficiency. Prof. Caulfield states that the diffractive features comprise refractive index variations that possess high contrast, which is in contradiction with the product one would reasonably expect that is produced using interference from broadband incoherent energy sources. Such evidence further supports the conclusion that the diffractive features are formed through non-interference effects. Prof. Caulfield concludes that the claimed method is therefore operable.

Prof. John Caulfield similarly concludes that the method of using a medium having a surface relief pattern on a surface thereof to manufacture a volume diffractive optical element through non-interference effects is operable. Prof. John Caulfield who witnessed the process states that the process works remarkably simply and fast. Moreover, Prof. Caulfield emphasizes that this method is completely new and surprising to him. Prof. Caulfield admits that he has sought ways to accomplish this goal for years without success. Prof. Caulfield further explains that this approach is quite revolutionary and different in kind from any technique know to him.

With regard to Claim 6, Claim 6 specifically recites that the medium has an index of refraction that is substantially the same as the index of refraction of the curable material. As set forth in the Declaration by Prof. John Caulfield, such a configuration is operable.

With respect to Claims 7 and 24, the Office Action states that heat can pass through the

relief layer but is not patterned by the relief surface and that electrons and other electric charges can neither pass through the layer bearing the relief image or be patterned by the relief surface.

Applicants respectfully disagree with the rejection of Claims 7 and 24 as originally filed that is set forth in the Office Action. Applicants, however, have amended Claims 7 and 24 to reduce the number of issues and advance prosecution. Claim 7 has been amended to recite that the energy is in the form of an electron beam. As stated in the Office Action, electron beams can be used for curing. In addition, electrons can also pass through materials, in contradiction to the statement made in the Office Action. For example, in some prior art methods where UV light cannot penetrate through a substrate carrier which is opaque, an electron beam can be used to fabricate holograms. Moreover, patterning of the electrons, which is referred to in the Office Action, is *not* required. Claim 7, which depends from independent Claim 1, for example, recites propagating energy through the medium and from the medium into the layer and producing the diffractive features *through non-interference effects*. Applicants maintain, therefore, that an electron beam may be employed.

Claim 24 as amended recites that the energy propagated through the medium and from the medium into the layer comprises electromagnetic energy comprising light. Applicants maintain that the light, including light outside the UV range, such as visible light, may be employed as well.

Accordingly, Applicants method set forth in Claims 1-40, 99, and 109-111 is therefore operable and does not lack utility. Similarly, the enablement requirement has been satisfied. Applicants therefore respectfully request that the rejection of Claims 1-40, 99, and 109-111 under 35 U.S.C. §101 and 35 U.S.C. §112, first paragraph, be withdrawn.

Rejections under 35 U.S.C. 102(b)

Claims 41-48 are rejected under 35 U.S.C. §102(b) as being fully anticipated by Shirasaki et al. (U.S. Patent No. 4,806,442). Claims 41-48 are also rejected under 35 U.S.C. §102(b) as being fully anticipated by Okai et al. (U.S. Patent No. 5,340,637).

Applicants point out that the Office Action on pages 2-3 states that with respect to Claims 41 and 47, the diffractive features need not be more than a mere surface relief grating or hologram, as the claim does not require refractive index modulation in the formed product.

Claims 41 and 47, however, are amended to recite diffractive features comprising refractive index variations.

As amended, Claim 41, for example, recites that the formation of the pattern of diffractive features, which comprise refractive index variations, is dependent on the surface relief features and substantially independent of any diffraction of the energy by the surface relief features. Claim 47 recites forming the diffractive features comprising refractive index variations in the layer of curable material by illuminating the contact area with light having an intensity distribution substantially free of interference fringes.

For a reference to anticipate, each and every element of the claim must be shown. Shirasaki et al and Okai et al, however, fail to disclose each of limitations recited in Claims 41-48.

For example, Shirasaki et al and Okai et al fail to teach the formation of the pattern of diffractive features comprising refractive index variations which is dependent on the surface relief features and substantially independent of any diffraction of the energy by the surface relief features. Shirasaki et al and Okai et al also do not show forming the diffractive features comprising refractive index variations in the layer of curable material by illuminating the contact area with light having an intensity distribution substantially free of interference fringes.

Instead, Shirasaki et al and Okai et al teach diffraction and formation of interference fringes. See, for example, Shirasaki et al, column 17, lines 27-39 and 47-57, which describe "transmitted lights 45 and diffracted lights 46" that form a pattern of "interference fringes." See also Okai et al, column 3, line 46, to column 4, line 33, wherein Okai et al teaches that "[i]t is therefore desirable to utilize the interference between the first order diffraction wave and the transmission waves" to form interference fringes as depicted in FIG. 3. Accordingly, Shirasaki et al and Okai et al, which teach diffraction and formation of interference fringes, do not anticipate independent Claims 41-48.

Furthermore, Shirasaki et al and Okai et al fail to disclose physically contacting the surface relief features with a layer of curable material, which is recited in independent Claims 41-48. Nowhere does Shirasaki et al state or show such contact. For example, FIGURES 24-25, do not depict contact with the layer of the curable material. Okai et al also teaches a gap. On column 5, lines 56-59, states that "[i]n order to protect the mask and to remove Newton ring that developed between the photomask 56 and the InP substrate 54, therefore, the exposure was

effected by providing a gap of 50 to 250 μm." Column 6, lines 45-55, refer to this same gap. Applicants submit therefore that Shirasaki et al and Okai et al fail to disclose physically contacting the surface relief features with a layer of curable material as recited in Claims 41-48.

Applicants submit that Shirasaki et al and Okai et al do not disclose other limitations recited in the rejected claims. For example, Shirasaki et al and Okai et al do not show that the cureable material comprises polymer selected from the group consisting of urethane, acrylate, and epoxy as recited in Claim 43. Shirasaki et al and Okai et al also do not teach that physically contacting the surface relief features comprises forming indentations in the layer of curable material, which is recited in Claim 45.

As Shirasaki et al and Okai et al fail to disclose each of the limitations recited in Claims 41-48, it is submitted that Shirasaki et al and Okai et al do not anticipate. Applicants therefore respectfully request that the rejection of Claims 41-48 under 35 U.S.C. §102(b) be withdrawn.

Rejections under 35 U.S.C. 103(a)

Claims 41-50 and 53 are rejected under 35 U.S.C. §103(a) as being unpatenable over Pettigrew et al (U.S. Patent No. 4,657,780). Claims 41-46 are also rejected under 35 U.S.C. §103(a) as being unpatentable over Ikeda et al (U.S. Patent No. 4,904,033), in view of Moss et al (U.S. Patent No. 5,315,417). Further, Claims 41-53 are rejected under 35 U.S.C. §103(a) as being unpatentable over Pettigrew et al, in view of Haugh (U.S. Patent No. 3,658,526). Additionally, Claims 41-59 are rejected under 35 U.S.C. §103(a) as being unpatentable over Pettigrew et al, and Haugh, in view of Ingwall et al (U.S. Patent No. 5,198,912) and Sutherland et al (WO 01/90822).

Applicants believe that Claims 41-53 are not obvious from the combination of cited references.

For example, Claims 41-53 are not obvious from the teaching of Pettigrew et al, taken alone or in any combination with Haugh, Ingwall, and Sutherland. Pettigrew et al, taken alone or in combination with the other cited references, fails to disclose forming diffractive features comprising refractive index variations wherein the formation of the pattern of diffractive feature is dependent on the surface relief features and substantially independent of any diffraction of the energy by the surface relief features as recited in Claim 41. The cited references also fail to show forming the diffractive features comprising refractive index variations in the layer of curable

material by illuminating the contact area with light having an intensity distribution substantially free of interference fringes as recited in Claim 47.

In addition, Ikeda et al taken in combination with Moss et al, also fail to teach the claimed invention. The combination of Ikeda et al and Moss et al teach diffraction and interference fringes. See, e.g., column 5, lines 7-26, wherein Ikeda et al teach that a "predetermined pattern of interference fringes 19 are formed in the photosensitive layer 15 on bisector lines between the zero-order transmission beams 18 and the first-order transmission diffraction beams 18, as shown in FIG. 6". Ikeda et al taken alone or in combination with the cited references also fails to disclose physically contacting the surface relief pattern with a layer of curable material, which is recited in Claims 41-53. In fact, the combination of Ikeda et al in and Moss et al fail to show a surface relief pattern.

The Office Action states that Moss et al teach that volume holograms have both modulation on the surface (surface relief or thin holograms) and fringes of refractive index modulation throughout the thickness (thick holograms). Applicants respectfully disagree. In column 2, line 14-16, Moss et al states that a volume transmission hologram has the ***properties*** of both a thick and a thin hologram. The property referred to by Moss et al is that a surface relief hologram has little or no directional sensitivity and will diffract and reconstruct light from any incoming angle with high efficiently. In column 2, lines 33-37, Moss et al refers to means for removing the thin hologram ***property*** of a volume transmission hologram. Moss et al proceeds to describe periodic variations in index of refraction at the surface of the recording layer as causing the surface to act as a planar phase grating even in the absence of surface deformation. See column 6, lines 7-14. Moss et al explains that the periodic variations in the index of refraction in the outermost thin sheet are a result of the high index contrast ends of the fringes (represented by 4 in FIG. 1b) that define the volume hologram. Moss et al teaches that a gradual interface boundary along the surface regions of the recording medium (see, e.g., FIG. 3a) will reduce the diffractive power in those regions. See also column 6, line 57, to column 7, line 22. Moss does not teach that the volume holograms have surface relief. Accordingly, neither Moss et al nor the combination of Ikeda et al and Moss et al teach the claimed invention.

Claims 41-53 are thus patentable over the cited references. Applicants respectfully request therefore that the rejection of Claims 41-53 under 35 U.S.C. §103(a) be withdrawn.

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CONCLUSION

Applicants have endeavored to address all of the Examiner's concerns as expressed in the outstanding Office Action. In light of the above remarks, reconsideration and withdrawal of the outstanding rejections is specifically requested.

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Respectfully submitted,

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Dated: 7/20/04

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